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DISCADE™

MULTI-CABLE SOLUTION TO COMMUNICATIONS SYSTEMS PROBLEMS

Presented to the IEEE Convention
March 22, 1971
New York City

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Multi-Cable Solution to Communications Systems Problems

INTRODUCTION

Although our American society has lived with television as a major advertising medium for more than twenty years, its full impact as a communications medium has not yet been felt. Except for limited closed-circuit applications for industrial, scientific or commercial use, the use of television has involved primarily commercial entertainment distribution ... with only a token educational and cultural broadcasting effort. The many possibilities for beneficial use will become evident upon the expansion of television service through the full development of cable systems. This expansion could mean an almost unlimited quantity of information, entertainment and public expression being made available to every home in the nation... as well as educational institutions, industries and business offices. Many as yet unplanned services will become feasible, perhaps providing some solutions to the increasing problems of our growing nation. Although we are addressing the technological issues which impede this expansion, we are also aware of the many political, social and economic issues which demand attention as well. These issues, involving the beneficial use of such expanded communications facilities, may be more difficult to solve than the technical problems of providing those facilities.

A majority of the papers published in the July, 1970, Proceedings of the IEEE, Vol. 58, No. 7, dealt with the current limitations and state-of-the-art of broadband coaxial cable technology. In these papers particular attention was given to the limiting parameters associated with the use of coaxial cable and repeater amplifiers in frequency-division multiplexed systems. There appears to be, therefore, good reason to question the adequacy of the basic broadband CATV distribution techniques, which were developed to provide community antenna service, to effectively satisfy today's telecommunications requirements. Anticipated future requirements for expanded program diversification and ancillary services in the public interest will impose even greater demands for increased performance, particularly in the large metropolitan areas. To meet these demands, and to provide for the future requirements of expanded service, we suggest an alternate solution to the problems associated with the frequency-division multiplexed cable distribution system.

GLOSSARY

DISCADE	A remotely switched cable distribution system in which one or more signals are distributed on each of several separate coaxial cables. The name is derived from "**DIS**crete **C**able **A**rea **D**istribution **E**quipment."
HEADEND	Antenna site signal processing equipment.
SIGNAL PROCESSOR	Single channel television signal heterodyne amplifier incorporating circuitry for conversion and control of frequency, signal level and passband response.
TRUNK SYSTEM	Signal transmission system from headend to various areas to be supplied with such signals.
SUB-TRUNK SYSTEM	Signal distribution system extending from the trunk system to the Area Distribution Centers.
AREA DISTRIBUTION CENTER (ADC)	Facility for remote subscriber controlled switching.
SWITCHING MODULE	Remotely controlled subscriber switch. Connects the individual subscriber's service drop to the selected sub-trunk cable through solid - state "cross - bar" type switching matrix.
SERVICE DROP	Coaxial cable extending from the Area Distribution Center (ADC) to the subscriber's television channel selector.
TRUNK AMPLIFIER	Repeater amplifier having an individual amplifier module for

* TM AMECO, 1971

each coaxial cable used in the trunk system. Two types are used: manually controlled gain and slope (MGC) and automatically controlled gain and slope (AGC).

BRIDGING AMPLIFIER — Isolation amplifier used for connection of sub-trunk system to the trunk system. Individual bridging amplifier modules are used for each coaxial cable.

CHANNEL SELECTOR — Subscriber's channel selection device from which control signals are transmitted to the switching module. It includes a channel selection indicator and the necessary frequency conversion circuitry.

LINE SPLITTER — Passive device for dividing the signal on coaxial cable(s) equally with optimum power transfer and minimum degradation of the signal quality.

DIRECTIONAL COUPLER — Passive device for dividing the signal on coaxial cable(s) with directional isolation (tap-to-output), optimum power transfer, and minimum degradation of the signal quality.

RETURN LOSS — Reflection coefficient expressed in decibels.

THE SYSTEM CONCEPT

The DISCADE (TM) system evolved during the process of solving several basic problems encountered in the design of CATV systems. These problems are:

1. The transmission by wire of several television channels over considerable distance with minimum degradation of the signal quality,

2. The distribution by wire of television channels within areas having high ambient VHF television signal levels.

3. Expanding the cable reception capacity of a standard television receiver beyond the standard twelve VHF television channels with a stable device that is simple to operate and maintain, does not create a limiting factor in cable system design and does not materially degrade the quality of the television picture.

The first of these problems was evident in the requirements expressed by an operator of a CATV system in a major Southeastern city. A highly reliable multi-channel transmission system was desired which would make available several "off-the-air" television signals at a "hub" location within the city. These signals were received at a mountain-top antenna site and were to be combined with local television channels at the hub. Minimum degradation of the distant signals' quality was considered essential to successful operation of the system. The use of frequency-division multiplexed signals carried on a single 0.750" coaxial cable, or 1" air-dielectric cable was considered and rejected due to the inherent degradation and reliability factors in the frequency-division multiplex technique.

The solution decided upon involved the construction of a space-division multiplexed sub-frequency (7-13 MHz) transmission system extending from the mountain-top antenna site to a distribution hub location. This system employed twelve 0.500" aluminum sheathed coaxial cables and solid-state signal processing equipment at the headend and hub locations. Output levels of +70 dBmV at the headend permitted the transmission of the signals over the 4.25 mile system without repeater amplifiers. Ten (10) repeater amplifiers would have been required if frequency-division multiplexing techniques had been used on a single 0.750" aluminum sheathed coaxial cable. Tests performed on this discrete cable transmission system indicated significant improvement in performance over that possible using broadband frequency-division multiplexing techniques (see Table 1).

TABLE 1
Test Data Obtained on the Huntsville, Alabama Discrete Cable Transmission System

Signal-to-Noise Ratio	53 dB
Cross-channel Interference	−100 dB
Envelope Delay Distortion	Negligible
Frequency Response (from 0.75 MHz below to 4.18 MHz above visual carrier frequency)	±0.5 dB

The second and third problems were encountered in the CATV systems in Daly City and Broadmoor, California. The transmitting antennas for Channels 2, 4, 5, 7 and 9 are located in close proximity to the approximately 16,000 homes within these two communities. Radiated signal levels from these five television transmitting antennas are sufficiently high as to indicate a probability of ghosting due to multi-path reception if carried on-channel in the system. Twenty-channel television service was a firm requirement for an economically viable system in the area. The use of non-standard carrier frequencies and set-top converters was considered and rejected due to the unavailability of suitable set-top converters. A triple-cable distribution system would be required if the five strong local channel frequencies were to be avoided and only the standard VHF channels used. The DISCADE concept was developed as a practical solution to the problems.

The DISCADE system is a remotely switched cable distribution system in which one or more television signals, or other communications signals are distributed on each of several

discrete coaxial cables. All switching and control functions are accomplished with solid-state circuitry. A single 75 ohm coaxial cable connects the subscriber's channel selector unit to the remote switching equipment. Through the use of both space-division and frequency-division multiplexing the limiting effects associated with either type of system are minimized. Distribution of an increased number of channels over a larger area, with high ambient VHF signals present is achieved. System reliability and maintainability are also improved by the simplification inherent in the DISCADE system.

In providing community antenna service, i.e., the distribution of "off-the-air" and locally originated television signals, the DISCADE system employs signal processing equipment similar to that used in conventional broadband systems. UHF television channels are received and converted to VHF channel frequencies by crystal-controlled conversion units. VHF channel television signals below 0 dBmV may be pre-amplified, if desired. The various VHF television signals, at levels of 0 to +10 dBmV, are connected to the input terminals of heterodyne signal processors.

The original Daly City DISCADE system consisted of a twenty-channel headend with each of the 7-13 MHz channels connected to a separate coaxial cable. Repeater amplifiers, containing 20 identical single channel amplification modules plus one for FM radio signals, were spaced approximately 5,000 ft. apart along the five mile trunk system. Four Area Distribution Centers, each with a capacity of 48 switching modules, were installed to provide service to 192 subscribers in a selected area of the city. Performance of the system was excellent and demonstrated an effective solution to the problems it was designed to solve. There were, however, some problems which became evident during this initial field test. The equipment, particularly the repeater amplifiers and Area Distribution Centers, was physically large and difficult to install under existing pole attachment practices. The system cost, as indicated by the cost of the pilot project, appeared to be uncomfortably high. One solution to the problem of equipment size appeared to be the more extensive use of integrated circuitry and other miniaturization techniques. A solution to the problem of cost which was considered was the use of extensive "hard" tooling and mass production methods. However, the solution to both problems was facilitated by the development of the DISCADE II system.

In the DISCADE II system two channels are carried on each cable. One-half of the VHF television signals are converted to channel "A" and one-half of the signals are converted to channel "B". Channel "A" uses a 35.25 MHz visual carrier frequency and a 39.75 MHz aural carrier frequency. Channel "B" uses a 23.25 MHz visual carrier frequency and a 27.75 MHz aural carrier frequency. One channel "A" and one channel "B" signal are combined and connected to each coaxial cable transmission line. The number of transmission lines used is determined by the total number of channels desired. In this twenty-channel television system a total of ten (10) television transmission lines, each carrying two channels, are used. An additional cable carries the FM radio band throughout the trunk portion of the system.

At the headend the various FM radio signals are converted individually to carrier frequencies in the 20 to 40 MHz band. These sub-frequency carrier FM radio signals are combined and connected to a trunk system cable. At the bridging amplifier locations a special block converter is used to convert the 20 to 40 MHz FM signals back to the 88 to 108 MHz band. This block converter occupies the space normally occupied by the sub-frequency FM signal amplifier module in trunk amplifiers. FM radio (88 to 108 MHz) signals are then diplexed onto each of the ten television cables at each bridging amplifier location. Consequently these radio signals are constantly present at the subscriber's channel selector, regardless of the television channel selected.

The subscriber's channel selector is designed so as to remotely switch from one line to the next on alternate channel selector switch positions. "A" and "B" frequency conversion oscillators are alternately switched on and off with each channel selection position. The combination of the two switch functions provides the desired VHF television channel frequency output.

All components of the sub-trunk and distribution system are designed to accommodate signals having carrier frequencies up to 120 MHz. A simple filter arrangement separates the FM radio band from the television signals on the subscriber's service drop and provides FM radio signals of at least 300 microvolts across 75 ohms.

The complete DISCADE II system consists of headend, trunk line transmission system, sub-trunk distribution system, area distribution centers, subscriber's drop or service cable and subscriber's channel selector unit. The size and cost of the cable and components in these portions of the system are reduced from those used in the original DISCADE system.

SYSTEM DESIGN

Headend System

The headend system consists of antennas and solid-state signal processors for each "off-the-air" television channel, modulators for each locally originated channel, signal combiners for each pair of "A" and "B" channels and signal processors for the particular FM radio channels carried on the system. The equipment is mounted in racks and is enclosed in an air conditioned building or room for minimum dust and a constant temperature (65° to 80°F).

The solid-state signal processors provide sufficient gain, automatically controlled, to ensure a constant output level of +40 dBmV on all television visual carrier frequencies. Aural carrier signals are separately processed and maintained at levels 15 dB below the visual carrier signals. Under typical operating conditions a minimum signal-to-noise ratio of 53 dB is achieved while maintaining a minimum 16 dB return loss on both input and output terminals. Swept frequency response of the signal processor is aligned for a ±0.25 dB flatness across the video information band. A minimum of 50 dB image and adjacent channel rejection is provided and all spurious frequency signals in the output are at least 60 dB down from the desired

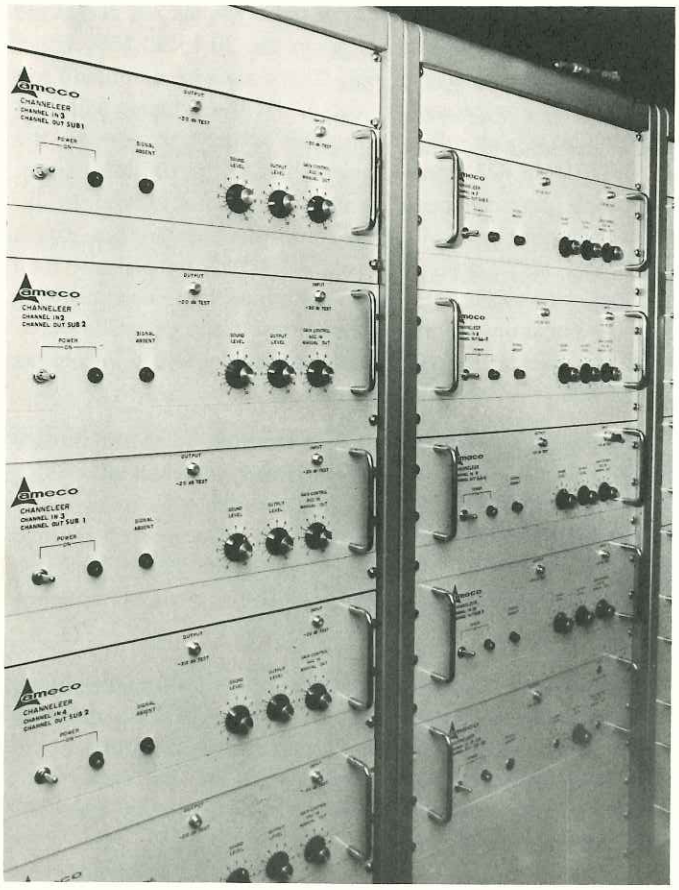


Figure 1 — HEADEND

Several of the "off-the-air" signal processors used in the Daly City, California 20-channel DISCADE II headend system.

output signal level. Negligible envelope delay distortion, differential phase or gain distortion, or other color signal degradation is contributed by the heterodyne signal processor equipment.

A complementary filter arrangement is used for combining the "A" and "B" channel frequencies at the headend. This combining method provides a high degree of isolation between the signal processors.

Trunk System

The trunk transmission system extends from the headend to the various areas wherein the signals are to be distributed. The trunk lines are never directly connected to the area distribution centers, or otherwise "tapped" for subscriber service. Signals are obtained from the trunk system through bridging amplifiers which provide high isolation from distribution facilities.

The trunk system for twenty-channel television transmission consists of ten aluminum sheathed, cellular polyethylene dielectric coaxial cables. Cable size ranges from .250" to .750" and is determined by system requirements. Table 2 shows the nominal attenuation at 40 MHz of several commonly used coaxial cables.

TABLE 2
Nominal Coaxial Cable Attenuation Chart

Cable Size	Nominal Attenuation at 40 MHz
.750"	0.35 dB/100 ft.
.500"	0.52 dB/100 ft.
.412"	0.64 dB/100 ft.
.250"	1.50 dB/100 ft.

In areas of light ice and wind loading 1/4" extra high-strength galvanized steel messenger wire is used for support of the cable and equipment on aerial systems. 5/16" or larger messenger wire may be used in areas having higher loading factors and for exceptionally long spans. Jacketed coaxial cables, encased in 4" diameter plastic conduit, are installed in underground portions of the system. Normal precautions are taken during construction to prevent moisture contamination and mechanical damage to the cables.

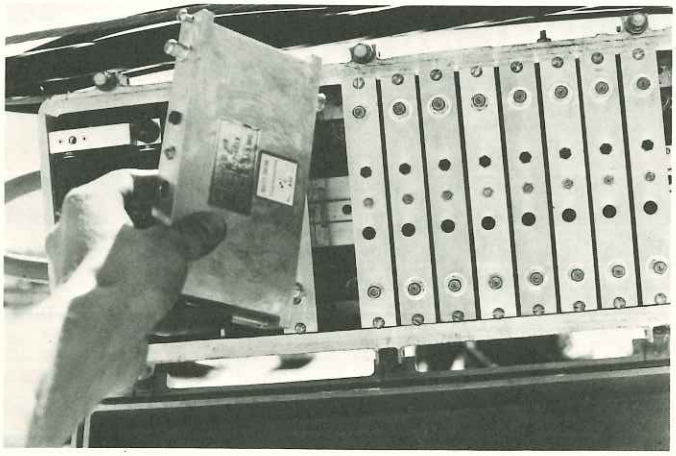


Figure 2 — TRUNK AMPLIFIER (AERIAL)

Symmetrical design of the amplifier modules provides for convenient reversal of the signal flow direction on any cable selected by removing module as shown, rotating it 180° and replacing it.

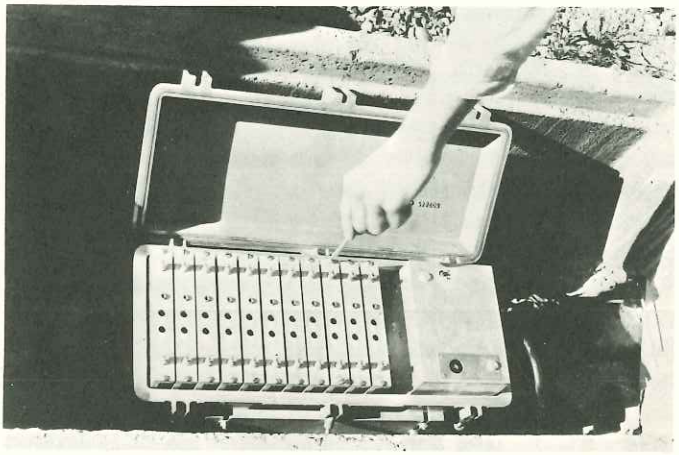


Figure 3 — TRUNK AMPLIFIER (UNDERGROUND)

One practical DISCADE amplifier installation method employs pre-fab concrete vaults as illustrated in this underground installation in Daly City, California.

Repeater amplifiers are placed in the system as necessary to compensate for the attenuation of the cable. These amplifiers are modular plug-in units with quick-disconnect type connectors on the modules. An individual shielded amplifier module is used for each cable. The amplifier modules are housed in a common die-cast aluminum housing with a common regulated D.C. power supply. Manual (MGC) or automatic (AGC) gain and slope control amplifiers are used as necessary to maintain signal levels constant within ±1.5 dB at any point on the trunk system with up to 100°F temperature variation. Bridging amplifiers are used to feed signals to the sub-trunk lines for distribution to the subscribers, and to provide block-converted FM signals. The amplifiers have electrical performance specifications as shown in Table 3.

copper, a 0.057" thick layer of foamed polyethylene to provide a 0.146" (O.D.) insulated conductor, and an outer sheath consisting of Dow type A-280 aluminum tape (0.008" x 5/8" wide) folded longitudinally around the insulated conductor and bonded to the outer jacket made of high-molecular-weight polyethylene, 0.025" thick. The individual coaxial cables weigh 39 lbs. per thousand feet.

The line splitters have approximately 3.5 dB tap and line insertion loss, and the hybrid directional couplers have approximately 1.0 dB line insertion loss (maximum) with 10, 14, 20, 26 or 32 dB tap loss. Isolation between the discrete line devices is at least 100 dB. Swept frequency response is flat within ±0.25 dB from 10 to 120 MHz. A minimum of 20 dB

TABLE 3
Typical Amplifier Performance Specifications

Characteristic	MGC Amplifier	AGC Amplifier	Bridging Amplifier *
Frequency Response (20 to 40 MHz)	± 0.1 dB	± 0.1 dB	± 0.2 dB
(10 to 50 MHz)	± 0.5 dB	± 0.5 dB	± 0.75 dB
Return Loss (Input and Output)	20 dB	20 dB	20 dB
Maximum Gain (40 MHz)	33 dB	35 dB	48 dB
Typical Operating Gain (40 MHz)	30 dB	30 dB	41 dB
Gain Control Range	+3, –4 dB	± 5 dB	– 5 dB
Noise Figure (operating gain)	8 dB	8 dB	12 dB
Cross-modulation (2-channel, at operating levels)	–87 dB	–87 dB	–60 dB*
Slope Control Range (cable equivalent)	± 2 dB	± 5 dB	+ 5 dB
Typical Input Level	+10 dBmV	+10 dBmV	+ 5 dBmV
Typical Output Level	+40 dBmV	+40 dBmV	+46 dBmV*
Isolation (line-to-line)	100 dB	100 dB	100 dB
Supply Voltage	90-125 VAC	90-125 VAC	90-125 VAC
Power Requirement (120 VAC)	142 watts	142 watts	142 watts

*On each of four output terminals.

Sub-Trunk System

The sub-trunk distribution system is fed from the trunk system through bridging amplifiers. It carries the signals from the trunk system to the various area distribution centers. Multi-cable line splitters and hybrid directional couplers are used as required for efficient distribution of the signals within the area. The sub-trunk distribution is usually constructed with .250" aluminum sheathed, cellular polyethylene dielectric, jacketed coaxial cables. (Larger size coaxial cables may also be used if required.)

The particular sub-trunk coaxial cable used in the DISCADE II system constructed has a 75 ohm characteristic impedance with a minimum structural return loss of 26 dB (5 to 50 MHz) and a nominal attenuation of 1.5 dB/100 ft. @ 40 MHz @ 68°F. It consists of a center conductor of 0.032" solid hard-drawn

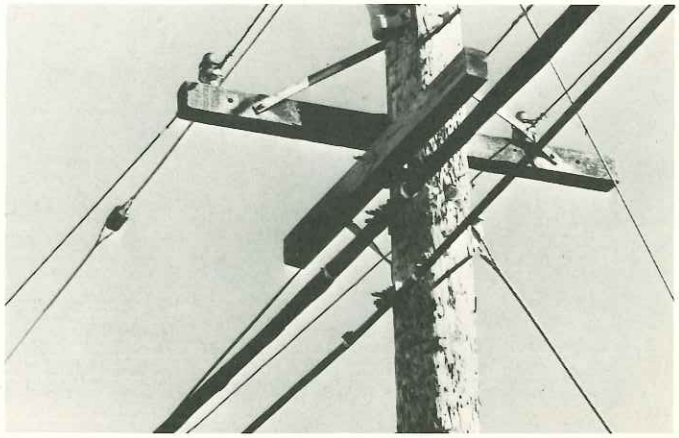


Figure 4 — SUB-TRUNK CABLE

Vertical pole-type aerial installation of DISCADE II trunk and sub-trunk cable (12 - 0.412" and 11 - 0.250" coaxial cables).

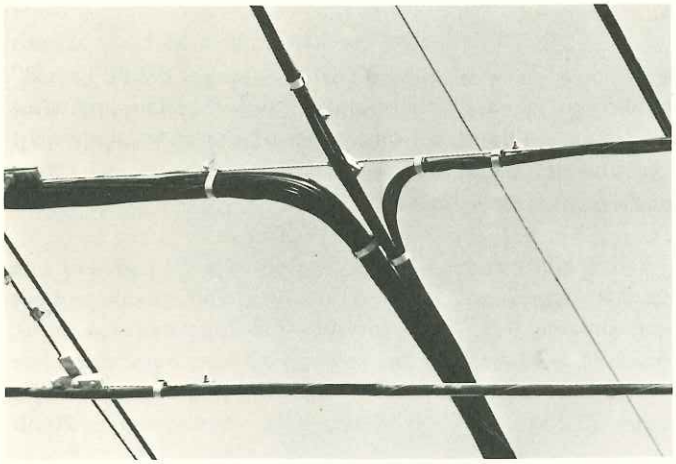


Figure 5 — CORNER CONSTRUCTION

Overhead DISCADE II cable installation showing 90° bend. Bend to the left contains 12 - 0.412" (trunk and AC power) cables, and other cables are 10 - 0.250" sub-trunk and one 0.412" AC power cable.

return loss is maintained on all ports of these passive devices. They are housed in cast aluminum cases with eleven (11) units per case.

Area Distribution Centers

Area Distribution Centers are installed as required to provide remotely controlled subscriber switching. These ADCs provide connection for 8, 16 or 24 subscriber switching modules in aluminum housings which are suitable for aerial or underground mounting. In the twenty-channel system installed, the ADCs contain ten (10) unbalanced striplines with signals from the ten (10) television cables and the FM radio band. Shunt loading effect of the switching modules is very low (18 K resistance + 6 pf capacitance) and this shunt loading effect is minimized by the use of lumped series inductors placed in the stripline. Up to ten ADCs may be installed in cascade (series) with channel-to-channel cross-view down at least 60 dB. Thru-line insertion loss is 0.5 dB per ADC.

The ADCs may be placed in the system so that average subscriber service drop cable lengths will meet system requirements. In field tests performed, subscriber service drop cables of over two thousand feet in length have been used successfully. Ordinary good quality, 96 percent braid coverage CATV-type drop cable is used. Grounding blocks are installed at the cable entrance to the building.

TABLE 4
Equipment Physical Characteristics

Equipment		Size	Weight
Signal Processor		19" x 17" x 5-1/4"	19 lbs.
Amplifier (Trunk or Bridging)		21" x 10-1/4" x 8-1/4"	42 lbs.
Area Distribution Center	(8 - Subscriber)	7-1/4" x 13-3/4" x 15"	38 lbs.
	(16 - Subscriber)	7-1/4" x 13-3/4" x 24"	66 lbs.
	(24 - Subscriber)	7-1/4" x 13-3/4" x 32"	90 lbs.
Line Splitter or Directional Coupler		4" x 6-1/4" x 14-1/2"	9 lbs.
Channel Selector Unit		6-1/4" x 6-1/4" x 3-3/8"	3 lbs.

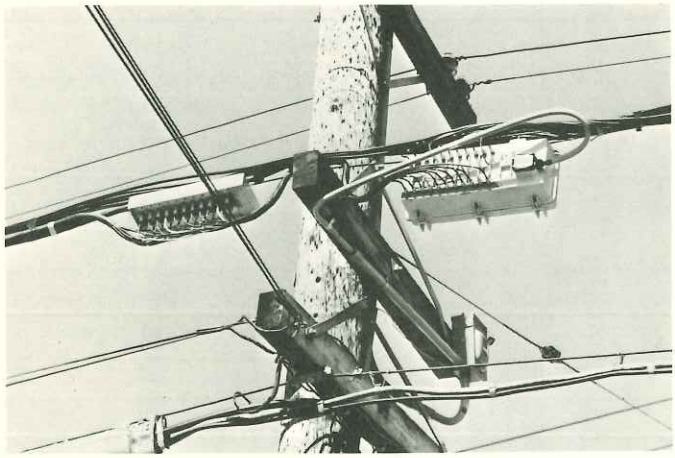


Figure 6 — BRIDGING AMPLIFIER

Strand-mounted bridging amplifier and directional coupler (top, left) showing AC power input from utility lines.

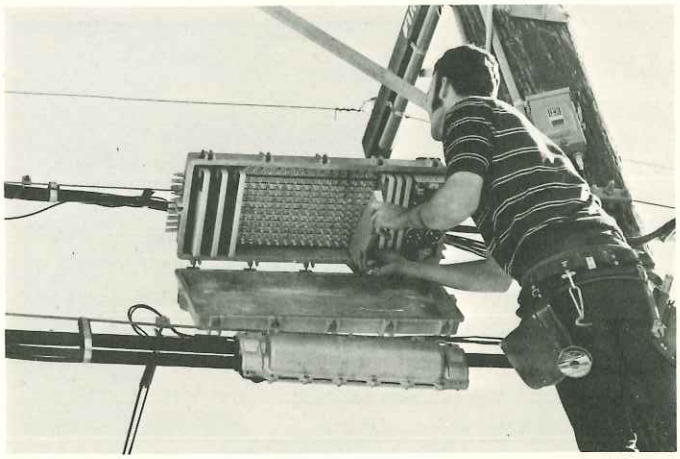


Figure 7 — 24-SUBSCRIBER ADC

Strand-mounted Area Distribution Center being installed in Daly City, California system by Construction Superintendent Mase Mattingly.

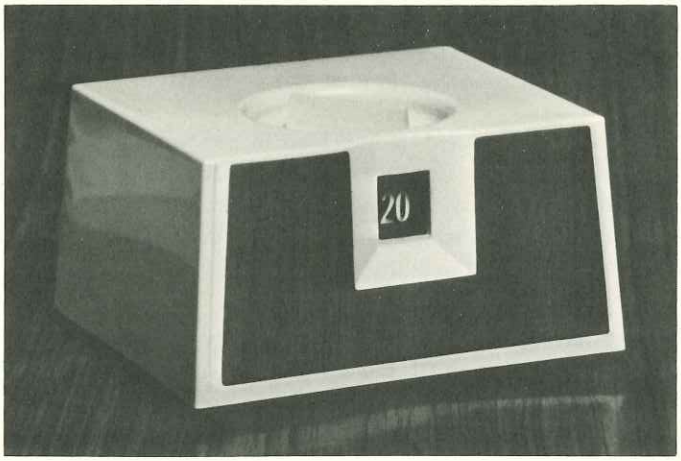


Figure 8 – CHANNEL SELECTOR

20-channel subscriber's channel selection unit as used in the Daly City, California DISCADE II system.

Channel Selection

The subscribers' channel selection is accomplished through manual operation of a channel selector unit. This unit has only two subscriber operated controls: a channel selector switch and an "on-off" switch. The channel selector switch mechanically controls the channel indicator and selects the appropriate oscillator for frequency conversion. It also initiates the required pulse for ADC switching to connect the proper sub-trunk cable signals to the subscriber's service drop cable. The unit is mounted conveniently on or near the television receiver and is connected to the receiver's VHF antenna input terminals. If desired, the television receiver's A.C. input power may be controlled through the channel selector's "on-off" switch.

The ADC switching module contains logic circuitry and solid-state switches which respond to the control signals from the subscriber's channel selector. A switching control pulse from the channel selector is detected at the subscriber's switching module and is applied to integrated circuit logic circuitry which causes the proper diode switch to be energized. The switching is arranged so as to operate sequentially and a reset signal is automatically transmitted from the channel selector between the 20th and the 1st channel positions. Channels are selected by clockwise rotation of the selector switch and a ratchet mechanism in the selector switch prevents counter-clockwise rotation of the switch.

In actual operation the television receiver is tuned to a locally "clear" channel for which the output of the channel selector unit was designed. The DISCADE channel selector activates the ADC switching module to which it is connected. Since there are two television channels on each cable, ADC switching is only necessary on odd channels (i.e., Channels 1, 3, 5 . . . 19) . . . the even channels are obtained through activation of a separate local oscillator and tuned filter network. Although approximately 3 dB gain is available from the frequency conversion in the channel selector, the primary consideration is impedance match, frequency response, noise figure and cross-channel interference.

A.C. Powering

A.C. power for operation of the repeater amplifiers, bridging amplifiers and Area Distribution Centers is obtained from utility line connections. 95 to 130 volts RMS is required for proper operation of the line equipment. Fused disconnect switches are used on the ungrounded side of the utility supply connection. Transmission of the A.C. power to the amplifier or ADC location is via coaxial cable with the outer sheath bonded to ground. Activated gas-tube surge protectors are used at the entrance ports of all connected equipment. All powering locations and all equipment housings are grounded through connection to driven earth grounds.

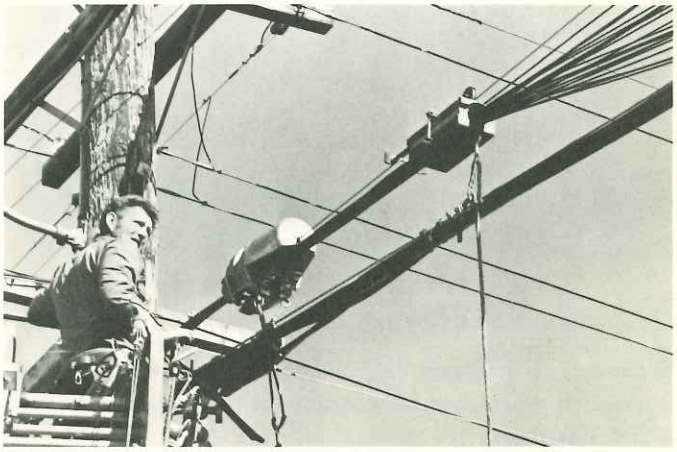


Figure 9 – CABLE LASHING

Aerial construction technique used in the installation of multiple 0.250" cables in the Daly City, California DISCADE II system. Cable being installed consists of two sub-trunk lines (twenty 0.250" and one 0.412" cable).

MISCELLANEOUS

A phase-lock loop system has been installed in the headend to minimize the effects of cross-view. All channel "A" signals are phase locked to one highly stable frequency standard, and all channel "B" signals are phase locked to another similar frequency standard. This feature significantly increases the viewer's tolerance of any accidental cross-view which may occur. It was determined in viewing tests that the threshold of visibility of cross-view was improved by approximately 15 dB through the use of phase locking. It also permits the system to comply with quite stringent frequency stability specifications.

In order to facilitate setting signal levels in the system a special signal level meter was developed which is capable of indicating two channels simultaneously. The instrument is battery or 115 volt line-powered (A.C.) and will indicate either the visual or aural carrier frequency levels depending on the position of switches provided for making this selection.

For DISCADE service within a hotel or apartment complex the ADCs may be rack mounted and installed in any convenient service area with separate subscriber drop cables to each room or apartment. Area conversion from the DISCADE channel

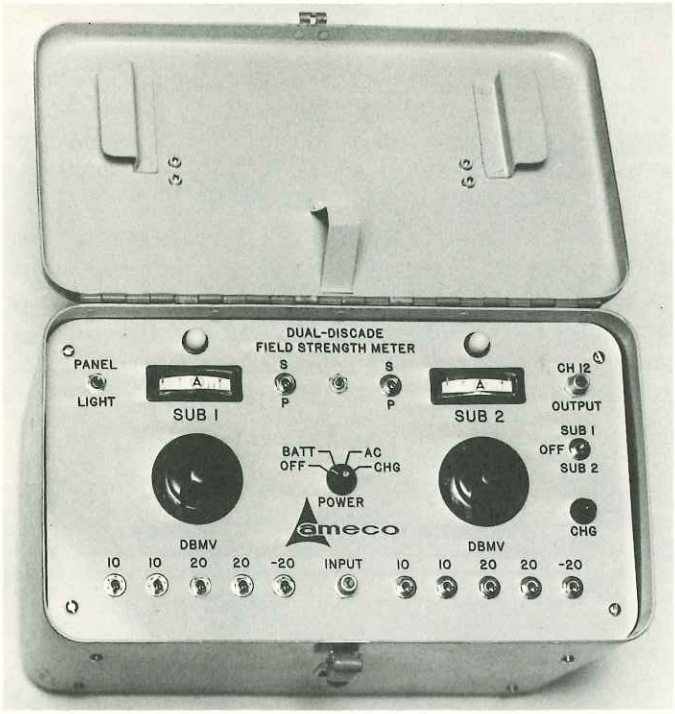


Figure 10 — SIGNAL LEVEL METER

R.F. levels are indicated on two carrier frequencies simultaneously.

frequencies to standard VHF television frequencies may also be provided, where necessary to connect to existing broadband MATV systems.

Another modification of the DISCADE system is currently being installed in the Disney World development near Orlando, Florida. In this system the frequency of the television signal, carried one channel per cable, matches the I.F. frequency of the television receivers being used. This eliminates the need for any tuning or conversion at the receiver.

Figure 11 — HOTEL ADC

Typical Area Distribution Center installation for DISCADE service to hotels, apartments or other multi-dwelling buildings. Unit shown has 240-subscriber capacity and is being constructed for a new hotel in Florida.

Additional development is indicated in connection with the use of more than two channels per cable, bi-directional operation including data transmission, improvement in performance and cost of the system, and in the investigation of the system's indicated flexibility of operation.

Current development programs include design of equipment for automatic monitoring of the subscribers' service connection to indicate the "on-off" and specific channel selection status of each connected television receiver. Development is in progress with respect to providing subscriber response and home security service. This feature will permit highly secure distribution and retrieval of information suitable for data processing. A new push-button channel selector providing random access is currently scheduled for production.

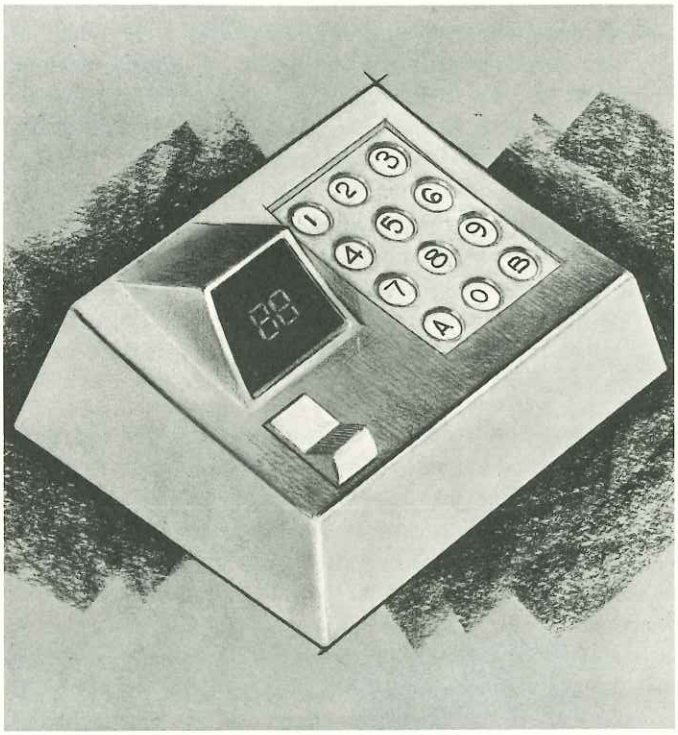
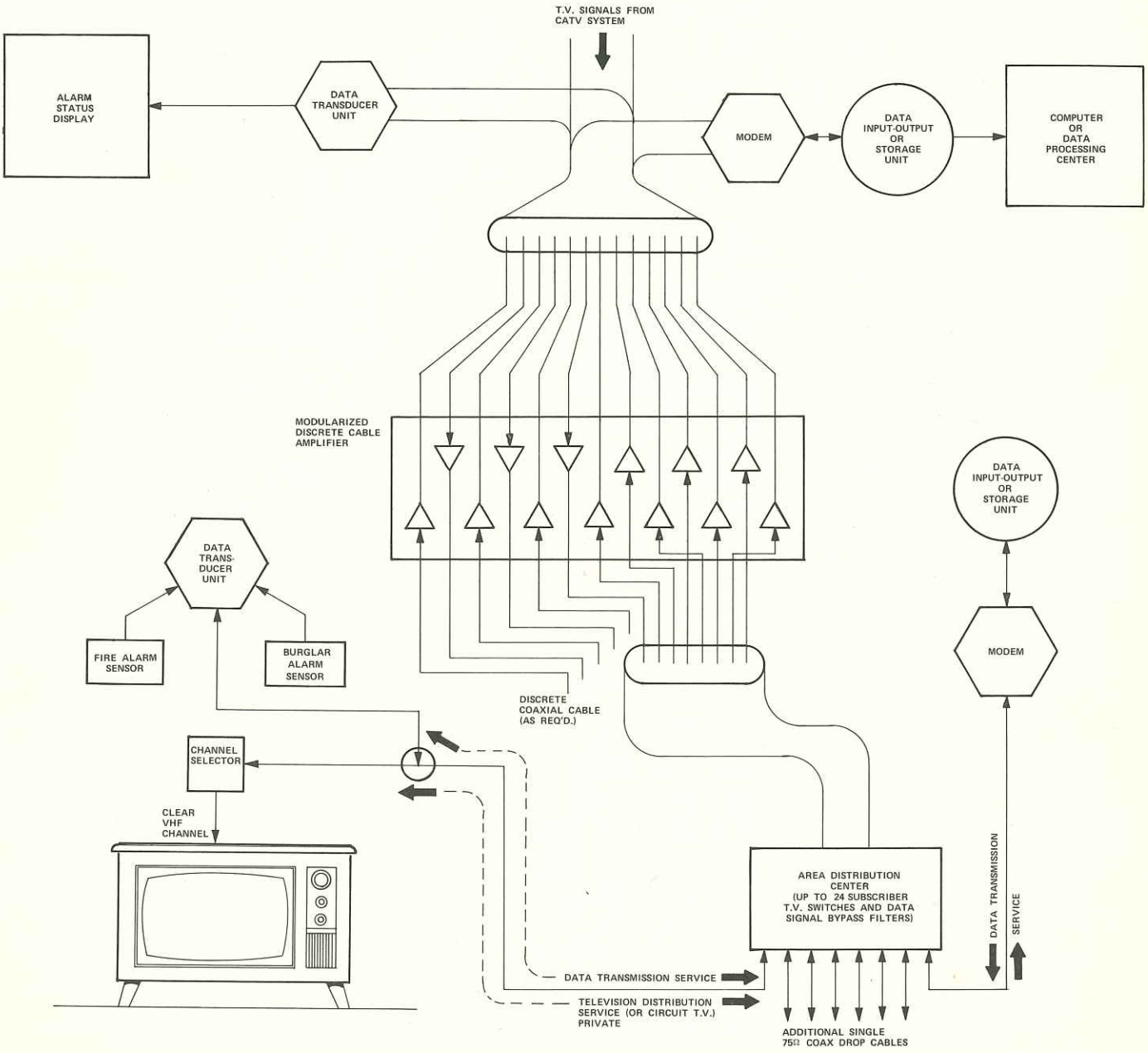


Figure 12 — PUSH-BUTTON SELECTOR

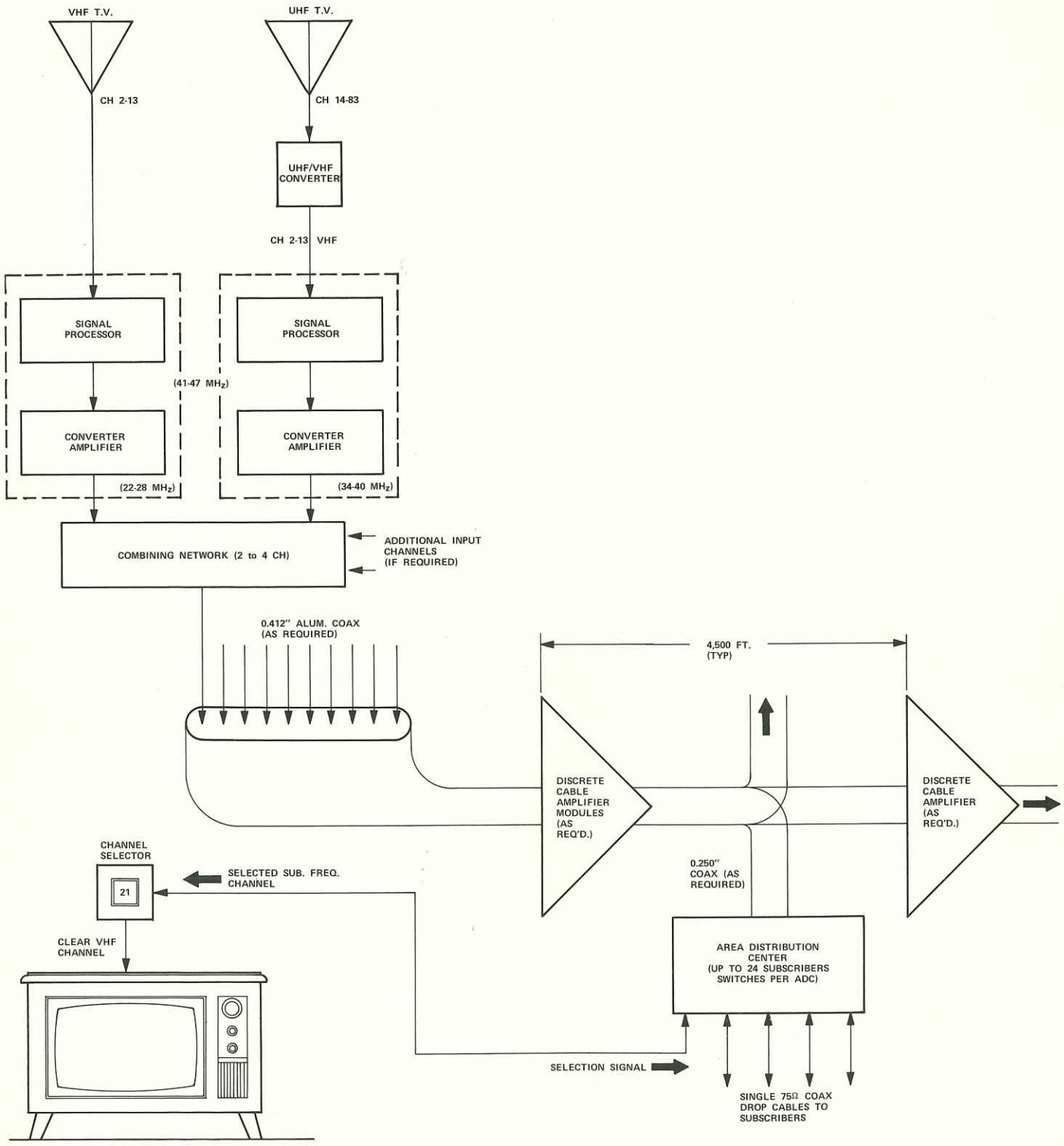
One of the proposed designs for the push-button channel selector currently under development.

SUMMARY AND CONCLUSION

The DISCADE II system installed in Daly City, California, has been demonstrated to exhibit a solution to the problems encountered in connection with the distribution of twenty channels of television and FM radio in that area. Results so far indicate its practicality in extending the system throughout wide metropolitan areas with less signal quality degradation than would otherwise be experienced with broadband techniques.


T.V. SIGNALS FROM CATV SYSTEM
ALARM STATUS DISPLAY
DATA TRANSDUCER UNIT
MODEM
DATA INPUT-OUTPUT OR STORAGE UNIT
COMPUTER OR DATA PROCESSING CENTER
MODULARIZED DISCRETE CABLE AMPLIFIER
DATA INPUT-OUTPUT OR STORAGE UNIT
DATA TRANS-DUCER UNIT
MODEM
FIRE ALARM SENSOR
BURGLAR ALARM SENSOR
DISCRETE COAXIAL CABLE (AS REQ'D.)
CHANNEL SELECTOR
CLEAR VHF CHANNEL
AREA DISTRIBUTION CENTER (UP TO 24 SUBSCRIBER T.V. SWITCHES AND DATA SIGNAL BYPASS FILTERS)
DATA TRANSMISSION SERVICE
DATA TRANSMISSION SERVICE
TELEVISION DISTRIBUTION SERVICE (OR CIRCUIT T.V.) PRIVATE
ADDITIONAL SINGLE 75Ω COAX DROP CABLES

DISCADE II FUNCTIONAL DIAGRAM ALARM & DATA TRANSMISSION SYSTEM



DISCADE II FUNCTIONAL DIAGRAM TELEVISION DISTRIBUTION SYSTEM

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